APPENDIX A

ESTIMATES OF REVENUE LOSS FROM TAX-EXEMPT STUDENT LOAN BONDS

The CBO estimates of the revenue loss from tax-exempt bonds are based on simulations of a general equilibrium model of portfolio choice and capital allocation. The model is labelled GEMDAT (General Equilibrium Model of Differential Asset Taxation) because it focuses on how investors choose among assets with different degrees of tax preference. GEMDAT is being continuously revised and updated; the simulations in this paper are from a version that reflects revisions completed in 1985, using 1983 data.1/

In the simulations presented below, the supply of tax-exempt bonds issued to finance federal programs increases by $10 billion, while the supply of taxable bonds declines by the same amount.2/ This change in asset supplies alters relative interest rates so that households are encouraged to absorb the additional supply of tax-exempt bonds. Two simulations are presented--one in which total physical capital stocks in each sector of the economy are held fixed and another in which the allocation of real capital among sectors is allowed to change in response to changes in relative costs of capital.[3]

The simulations should be viewed as illustrative for two reasons. First, the behavioral parameters of the model, although derived from

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1. GEMDAT was originally developed by Harvey Galper and Eric Toder, with subsequent revisions by the original authors and Robert Lucke. For the most complete description of the version of the model used in this paper, see Harvey Galper, Robert Lucke, and Eric Toder, *Taxation, Portfolio Choice, and the Allocation of Capital: A General Equilibrium Approach*, Brookings Discussion Papers in Economics (Washington, D.C.: The Brookings Institution, March 1986).

2. The federal government does not issue tax-exempt bonds directly. The proceeds of the bond issues, however, ultimately are made available for a federally guaranteed loan to students. The question turns upon whether the ultimate source of finance for this federal program is tax-exempt bonds issued by state authorities, or debt instruments of Sallie Mae or commercial banks.

3. For similar simulations of the revenue loss from tax-exempt bonds, using an earlier version of the same model, see Eric Toder and Thomas Neubig, "Revenue Costs of Tax Expenditures: The Case of Tax-Exempt Bonds," *National Tax Journal*, vol. xxxviii, no. 3 (September 1985).

standard portfolio choice theory, have not been tested empirically. Thus, the degree of substitution among assets by households may be different than represented here. Second, the model is solved for a particular set of asset holdings and interest rates, designed to represent values prevailing in 1983. Since 1983, both interest rates and total quantities of assets, in particular the stock of tax-exempt bonds held by households, have changed considerably. Thus, the absolute value of the revenue loss per dollar of bonds may be very different today than in 1983, although the relationship between the revenue loss and the yield spread should be similar.

BRIEF DESCRIPTION OF GENERAL FEATURES OF MODEL

In GEMDAT, financial assets are supplied to households by three capital-using sectors--corporations, noncorporate businesses, and state and local governments--and by the federal government, which issues taxable debt. There are 400 representative households in the model, weighted to add up to the entire taxpaying population. The households are selected by dividing taxpayers into 10 labor income groups, 10 capital income groups, itemizers and nonitemizers, and filers of joint and single returns. Each household allocates a fixed amount of wealth among four financial assets--taxable bonds, tax-exempt bonds, corporate shares, and shares in noncorporate business--and household-sector capital, which includes owner-occupied homes and consumer durables. Households choose their financial portfolios so as to maximize utility, which varies positively with expected income and negatively with the variance of income.

The amount of each type of asset supplied to households depends on the desired capital stock in each sector (corporate, noncorporate business, and state and local) and the debt-equity ratio of corporations. The desired capital stocks themselves depend on relative costs of capital. The demand for each asset by households depends on the asset's relative after-tax return, compared to the after-tax return on taxable bonds, and on the asset's expected after-tax variance. Taxable bonds are treated as a riskless asset in the model (zero variance), while the other assets all are assigned a positive risk.[4]

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4 Of course, taxable bonds are also risky because their capital value can change with changes in market interest rates. The simplifying assumption that taxable bonds are riskless may be justified because in fact the variance on long-term taxable bonds appears to be smaller than the variance on other financial assets. For example, using data and a methodology developed by Ibbotson and Sinquefield, we compute variances on the inflation-adjusted total return of .0092 for long-term corporate bonds, .0335 for common strocks, and .0190 for a Standard and Poor's index of 20-year tax-exempt bonds for the years 1952-84. For similar computations for corporate bonds and stocks,

The model solves for the interest rates on taxable bonds and tax-exempt bonds and the pretax returns to individuals on corporate stocks and investments in noncorporate business that equalize the demands and supplies for all assets. At these interest rates, one can then compute the value of physical capital in each sector, total assets held by each household, and total tax revenue.[5]

TREATMENT OF TAX-EXEMPT BONDS IN THE MODEL

In GEMDAT, tax-exempt bonds are supplied to households by state and local governments and corporations. State and local governments issue tax-exempt bonds to finance holdings of public-sector capital, such as schools and highways. The cost of capital to state and local governments is taken to be the real tax-exempt interest rate. State and local governments also issue tax-exempt bonds, the proceeds of which are made available for investments by private firms and individuals. In the model, private-purpose bonds are treated as if issued directly by the sector that is the ultimate user. Thus, industrial development bonds (IDBs) are modelled as tax-exempt bonds issued directly by the corporate sector. Corporate tax-exempt borrowing is initially set at 1983 levels of IDBs and then held at a constant proportion of total corporate debt in simulations of the model.

The proceeds of student loan bonds are used for a federal lending program--the Guaranteed Student Loan (GSL) Program. The ultimate supplier of funds is the household (or institution) that purchases a tax-exempt bond; the proceeds of this bond issue are then ultimately lent, with a federal guarantee, to the student, who is the final user. The conditions of GSLs, including the federal guarantee and the interest rate to borrowers (though not the subsidy payments to intermediaries), are unaffected by whether the ultimate supplier of funds is receiving tax-exempt or taxable interest.

For this reason, the model treats student loan bonds as a substitution of tax-exempt for taxable federal debt. In either case, the federal government is making or guaranteeing the same loan to a student, but in the

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4 see Roger G. Ibbotson and Rex A. Sinquefield, *Stocks, Bonds, Bills and Inflation: The Past and Future* (Charlottesville, Virginia: The Financial Analysts Research Foundation, 1982). Ibbotson and Sinquefield do not compute returns on tax-exempt bonds.

5 The equations of this model are presented in Galper, Lucke, and Toder, pp. 5-16.

case of student loan bonds the loan is financed by issuing tax-exempt bonds. This means that the supply of tax-exempt debt to individuals is increased by the same amount that the supply of taxable debt is reduced.

On the demand side of the model, tax-exempt bonds are held by both individuals and financial intermediaries. GEMDAT generally does not consider the role of financial intermediaries; real capital held by capital-using sectors is linked directly to financial assets held by individuals. An exception is made in the case of tax-exempt bonds because, in 1983, about two-thirds of tax-exempt bonds were held by financial intermediaries (mainly commercial banks and property and casualty insurance companies).6/If the model allowed all tax-exempt bonds to be absorbed directly into the portfolios of households, it would seriously overstate opportunities for tax-exemption available to households and understate the proportional increase in tax-exempt bonds available to households when the total supply of these bonds increases. The stock of tax-exempt bonds held by financial intermediaries is initially set at $295 billion (for 1983)7/ and held fixed in the simulations. This means that marginal increases in tax-exempt bonds are all absorbed by individuals.8/ To maintain the equality between demand and supply for all financial assets in the model, tax-exempt bonds held by financial institutions are treated as if financed by taxable debt held by households. Households receive the same return from these assets as on other taxable bonds, but users of capital services obtain the funds at the (lower) tax-exempt rate. The difference between the taxable rate received by lenders and the tax-exempt rate paid by borrowers represents a federal subsidy to activities financed by tax-exempt bonds conveyed in the form of a reduction in taxes that would otherwise be paid by financial intermediaries.

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6. Both the amount and share of tax-exempt bonds held by individual taxpayers instead of institutions has increased between 1983 and the end of 1985.

7. The data on tax-exempt bond holdings used in the model were based on estimates published by the Federal Reserve Board. See Board of Governors of the Federal Reserve System, *Balance Sheets for the U.S. Economy, 1945-83* (April 1984).

8. The same assumption was used in Toder and Neubig, "Revenue Costs of Tax Expenditures," and in Roger Kormendi and Thomas Nagle, "The Interest Rate and Tax Revenue Effects of Mortgage Revenue Bonds," in George C. Kaufman, ed., *Efficiency in the Municipal Bond Market: The Use of Tax-Exempt Financing for Private Purposes* (Greenwich, Conn.: JAI Press, 1981). An earlier paper by Hendershott and Koch shows demand for tax-exempt bonds by financial institutions to be relatively insensitive to changes in tax-exempt yields. See Patric Hendershott and Timothy Koch, "The Demand for Tax-Exempt Securities by Financial Institutions," *Journal of Finance*, vol. 35, no. 3 (June 1980).

In general, the model assigns financial assets among the representative households in proportion to income from the assets reported on tax returns. Tax-exempt bond holdings were imputed to households based on data from the *Survey of Consumer Finances.* Based on this data, a very large share of tax-exempt bonds held by individuals is assigned to high-income taxpayers in marginal tax brackets above 40 percent.

Simulations of the Model

The revenue effects of student loan bonds were estimated by simulating the effects of issuing $10 billion of tax-exempt federal debt to replace an equal amount of taxable federal bonds. Two separate simulations were performed. In the first simulation, total capital stocks--state and local capital, corporate capital, noncorporate business capital, and owner-occupied homes and consumer durables--were all held fixed. In addition, a weighted average of interest rates was held fixed. Relative returns on different financial assets, however, were allowed to adjust to enable households to absorb the new set of asset supplies. This simulation provides a "static" estimate in the sense that real economic outputs are unaltered. It is still necessary, however, even with static economic assumptions, to know the marginal tax rates of those who will absorb the additional tax-exempt bonds in order to compute the revenue loss from narrowing the tax base.

The second simulation, labelled the "full model" simulation in the tables, allows real capital stocks to adjust in response to changes in the cost of capital resulting from changes in relative yields on financial assets. The demand for capital services is taken to be a function of real costs of capital, with a demand elasticity of minus one. This means that total real capital income originating in each sector is held fixed, because the percentage change in the amount of capital in any sector exactly offsets the percentage change in the real cost of capital. While relative capital stocks change, total private saving, and therefore the sum of capital stocks in all sectors, is still held fixed.

Table A-1 shows the effects of substituting $10 billion of tax-exempt bonds for taxable student loan finance on interest rates, the allocation of the capital stock, holdings of financial assets, and the corporate debt-equity ratio. The top panel of the table shows that, while the yields on all assets change, only the yield on tax-exempt bonds increases by more than 0.5 basis points. The tax-exempt rate increases by 4 basis points when capital stocks are held fixed, and by 3 basis points in the full model simulation. Although not shown on the table, it is worth noting that the yield on taxable bonds declines by 0.3 basis points.

TABLE A-1. SIMULATED EFFECTS ON RATES OF RETURN, CAPITAL ALLOCATION, AND ASSET HOLDINGS OF SUBSTITUTION OF $10 BILLION OF TAX-EXEMPT FOR TAXABLE BONDS IN FINANCING GUARANTEED STUDENT LOANS (1983 LEVELS)

Pretax Rates of Return	Base Case (percent)	Simulated Changes (Basis Points) Capital Stock Held Fixed	Simulated Changes (Basis Points) Full Model
Taxable Bonds	11.64	*	*
Corporate Equity	14.05	*	*
Tax-Exempt Bonds	8.74	+4	+3
Noncorporate Capital	16.02	*	*

Capital Stocks and Financial Assets	Base Case (billions of dollars)	Simulated Changes (Billions of Dollars) Capital Stock Held Fixed	Simulated Changes (Billions of Dollars) Full Model
Corporate Capital	2,389.5	0	+0.5
Noncorporate Capital	1,983.0	0	+0.2
State and Local Capital	376.3	0	-1.4
Household Capital	3,188.0	0	+0.7
Net Taxable Bonds	2,105.0	-10.0	-9.0
Corporate Equity	1,653.6	0	-0.5
Tax-Exempt Bonds	160.0	+10.0	+8.6
Corporate Debt-Equity Ratio	0.445	0.445	0.446

* Less than 0.5 basis points.

The bottom panel of the table shows the effects on capital stocks and financial assets. When the capital stock is held fixed, all changes in real capital stocks are set to zero by assumption and total changes in supplies of taxable bonds and tax-exempt bonds are exactly equal to the initial changes--an increase of $10 billion in tax-exempt bonds and a reduction of $10 billion in taxable bonds. In the full model simulation, capital stocks respond to changes in pretax rates of return on assets issued by the capital-using sectors. Because the tax-exempt rate rises, the state and local sector contracts slightly. State and local capital declines by $1.4 billion, thus offsetting in part the initial increase in the supply of tax-exempt bonds. Corporate tax-exempt borrowing increases, however, because the corporate capital stock rises by $0.5 billion. Household capital (homes and consumer durables) increases by $0.7 billion in response to the (slight) decline in the cost of taxable debt. All of these secondary changes are much smaller than the initial $10 billion increase in the supply of tax-exempt bonds.

Table A-2 summarizes the revenue effects estimated from simulating the model. The total revenue loss from the $10 billion of bonds is almost the same in the two simulations, but the composition of the revenue change is different. In the full model simulation, corporations respond to changes in interest rates by increasing the debt-equity ratio slightly. The increase in corporate borrowing lowers corporate revenue, because corporate interest payments, but not corporate payments to equity owners, are deductible in computing corporate taxable income. At the same time, the increase in corporate debt, by making more taxable bonds available to individuals, increases individual taxable income and revenues. Thus, in the simulation with capital stocks held fixed, individual revenue declines by $366 million and corporate revenue by $15 million; when real capital stocks and corporate debt-equity ratios are allowed to adjust, the individual revenue loss declines to $342 million, but the reduction in corporate revenues increases to $37 million.

In both simulations, taxes paid by financial intermediaries increase by an estimated $4 million. This is a result of the modest decline in taxable interest rates, which reduces the tax saving from financing tax-exempt holdings with deductible taxable debt.

The decline in taxable interest rates also reduces the long-term costs of the remaining taxable federal debt. As shown in the second panel of Table A-2, the decline in federal interest costs is about $35 million. This is a long-run estimate; in the short run, a much smaller saving will be achieved because payments are fixed on the outstanding bonds. The savings are only achieved when the debt is refinanced. The $35 million saving on interest costs reduces the overall revenue loss to $342 million in the simulation with the capital stock held fixed and to $340 million in the full model simulation.

It is useful to compare these estimates to those that would result from a simpler model in which additional supplies of tax-exempt bonds are absorbed by investors with a marginal tax rate equal to $(i_f - i_e)/i_f$, where i_f is the taxable interest rate and i_e is the tax-exempt interest rate. This simple model can be called an "income maximization" model because investors simply choose the asset which has the highest after-tax return. Additional supplies of tax-exempt bonds are then absorbed by those who receive the same after-tax return on both taxables and tax-exempts.

TABLE A-2. SIMULATED LONG-TERM BUDGETARY EFFECTS OF SUBSTITUTING $10 BILLION OF TAX-EXEMPT FOR TAXABLE BONDS IN FINANCING GUARANTEED STUDENT LOANS (In millions of dollars)

	Simulated Changes	
	Capital Stock Held Fixed	Full Model
Individual Taxpayers	-366	-342
Nonfinancial Corporations	-15	-37
Financial Intermediaries	+4	+4
Total Revenue Change	-377	-375
Change in Federal Interest on Outstanding Taxable Debt	-35	-35
Net Budgetary Effect	-342	-340
Implied Marginal Tax Rate for Measuring Loss (percent)		
Individual revenue changes only	31.5	29.4
All revenue changes	32.4	32.2
All budget changes	29.4	29.2

Given the initial interest rates used in the simulations (11.64 percent for taxable bonds, and 8.74 percent for tax-exempt bonds), the income maximization model implies that additional tax-exempt bonds will be absorbed by taxpayers in the 25 percent bracket. In contrast, the simulations shown in Table A-2 find a total revenue loss equal to about 32 percent of the initial reduction in taxable income. The total increase in the budget deficit, taking account of the long-run saving to the federal government from lower taxable interest rates, is about 29 percent of the initial reduction in taxable income. These results suggest that the income maximization model slightly understates the revenue loss from tax-exempt bonds.

Tables A-3 and A-4 provide more detail on the portfolio shifts that produce these results. Table A-3 shows the portfolio shifts when capital stocks are held fixed. In the simulation, over 70 percent of the additional supply of tax-exempt bonds is absorbed by taxpayers with adjusted gross income (agi) between $30,000 and $50,000. These are taxpayers with marginal tax rates in the 25-35 percent range. An additional 20 percent of the bonds, however, are absorbed by taxpayers with income above $50,000. These are investors who receive a higher return on tax-exempts than on taxable bonds, but who hold less than the income-maximizing amount of tax-exempts to reduce risk. As the tax-exempt rate rises relative to the taxable rate, they increase the share of tax-exempts in their portfolios.

Table A-4 shows changes in asset holdings by income group in the full model simulation. The general patterns of asset shifts are quite similar, except that the total change in both taxable and tax-exempt bonds is now less than the initial change. Corporate equity holdings now decline slightly and holdings of household sector capital increase. The changes in total assets held by households mirror changes in assets supplied by the capital-using sectors that occur in response to changes in relative real costs of capital.

CONCLUSIONS

This appendix has presented estimates of the federal revenue losses from substituting tax-exempt for taxable sources of finance of GSLs. The results of the simulations are consistent with earlier estimates that the budgetary cost of tax-exempt bonds is slightly larger than the product of the percentage yield spread, the taxable interest rate, and the volume of additional bonds. At a 25 percent yield spread, the simulations show a revenue loss equal to approximately 32 percent of the change in taxable

income. If long-run effects of lower interest rates on federal debt costs are taken into account, the net budgetary effect is slightly lower--about 29 percent of the initial reduction in taxable income.

These results are consistent with the view that the federal revenue loss from tax-exempt bonds is greater than the interest savings to tax-exempt borrowers. It is also consistent with a conclusion that, even with a 50 percent lower special allowance payment, total federal budgetary costs are in most cases increased by substituting student loan bonds for taxable sources of funds.

Although these results are the product of a fairly sophisticated modelling effort, they cannot be taken as definitive and final. Much more work needs to be done to understand the financial portfolio behavior that lies behind these estimates. In particular, there is very little empirical evidence on how changes in the relative yields among assets affect demands

TABLE A-3. SIMULATED EFFECTS ON INDIVIDUAL ASSET HOLDINGS BY INCOME CLASS OF SUBSTITUTION OF $10 BILLION OF TAX-EXEMPT FOR TAXABLE BONDS IN FINANCING GUARANTEED STUDENT LOANS: CAPITAL STOCK HELD FIXED (Changes in billions of dollars)

Adjusted Gross Income ($000)	Taxable Bonds	Corporate Equity	Non-Corporate Capital	Tax-Exempt Bonds	Household Capital
0 - 5	*	*	*	0	0
5 - 10	*	*	*	0	0
10 - 15	*	*	*	0	0
15 - 20	*	*	*	0	0
20 - 30	-0.6	*	*	+0.5	0
30 - 50	-7.2	*	0	+7.2	0
50 - 100	-0.7	*	*	+0.7	0
100- 200	-0.6	*	*	+0.6	0
200+	-0.8	*	*	+0.8	0
Pensions	*	*	0	0	0
Total	-10.0	0	0	+10.0	0

* Less than $50 million.

by different types of investors. Further work in this area is needed before much confidence can be placed in any assumptions about who would absorb an additional supply of tax-exempt securities. This information about likely portfolio shifts is essential for the revenue estimates because the estimates require knowing the rate at which any change in taxable income would have been taxed.

TABLE A-4. SIMULATED EFFECTS ON INDIVIDUAL ASSET HOLDINGS BY INCOME CLASS OF SUBSTITUTION OF $10 BILLION OF TAX-EXEMPT FOR TAXABLE BONDS IN FINANCING GUARANTEED STUDENT LOANS: FULL MODEL SIMULATION
(Changes in billions of dollars)

Adjusted Gross Income ($000)	Taxable Bonds	Corporate Equity	Non-Corporate Capital	Tax-Exempt Bonds	Household Capital
0 - 5	*	*	*	0	*
5 - 10	*	*	*	0	*
10 - 15	*	*	*	0	*
15 - 20	-0.1	*	*	0	+0.1
20 - 30	-0.6	*	*	+0.5	+0.1
30 - 50	-6.4	-0.1	*	+6.2	+0.3
50 - 100	-0.7	-0.1	*	+0.7	+0.1
100- 200	-0.5	-0.1	*	+0.5	*
200+	-0.7	-0.1	*	+0.7	*
Pensions	+0.1	-0.1	0	0	0
Total	-9.0	-0.5	+0.1	+8.6	+0.7

* Less than $50 million.

APPENDIX B

NEW ISSUES OF TAX-EXEMPT STUDENT LOAN BONDS BY STATE, (IN MILLIONS OF DOLLARS) 1983-1985 a/

State	1983	1984	1985
Alabama	75	---	---
Alaska	---	---	---
Arizona	204	---	66
Arkansas	---	---	30
California	576	128	820
Colorado	133	---	147
Connecticut	16	---	15
Delaware	---	---	---
Florida	---	---	---
Georgia	---	---	31
Hawaii	---	---	---
Idaho	17	37	---
Illinois	159	132	65
Indiana	82	---	---
Iowa	60	11	46
Kansas	---	---	---
Kentucky	119	41	109
Louisiana	---	196	2
Maine	6	---	---
Maryland	---	14	---
Massachusetts	132	122	306
Michigan	---	---	---
Minnesota	168	60	---
Mississippi	20	---	85
Missouri	---	---	35
Montana	34	68	---
Nebraska	---	---	143
Nevada	---	---	---

(Continued)

State	1983	1984	1985
New Hampshire	42	5	39
New Jersey	---	---	---
New Mexico	42	---	44
New York	---	---	95
North Carolina	---	---	---
North Dakota	---	128	125
Ohio	198	---	b/
Oklahoma	---	---	---
Oregon	---	---	---
Pennsylvania	201	200	36
Rhode Island	---	---	---
South Carolina	50	---	---
South Dakota	25	49	120
Tennessee	---	---	---
Texas	259	25	345
Utah	50	---	---
Vermont	75	---	84
Virginia	299	88	---
Washington	---	46	45
West Virginia	---	---	---
Wisconsin	46	20	19
Wyoming	---	---	---
Other c/	---	---	50
Total	3,088	1,370	2,902

SOURCE: Department of the Treasury, Office of Tax Analysis (July 15, 1986).

a. Excludes bonds to refund outstanding obligations.

b. Less than $500,000.

c. Includes the District of Columbia, Puerto Rico, Guam and the Virgin Islands.